RESEARCH ARTICLE

INTERNATIONAL JOURNAL OF KINANTHROPOMETRY

DOI: 10.34256/ijk2615

The Effect of Anthropometric Measurement on Cycling Performance among Competitive Cyclists in the Western Province of Sri Lanka

K.T.T.D. Kalubovila [1,*], P. Buvanendiran [1], D.S. Weerasinghe [1]

[1] Faculty of Science, University of Kelaniya, Sri Lanka.
* Corresponding author email: tharinditaniya@gmail.com
DOI: https://doi.org/10.34256/ijk2615
Received: 13-01-2026; Revised: 26-03-2026; Accepted: 02-04-2026; Published: 10-04-2026

Abstract

Introduction: The relationship between the anthropometric characteristics of lower limbs and 1 km cycling performance among the competitive cyclists in the Western Province of Sri Lanka. A cross-sectional research design which was descriptive was used. Simple random sampling was used in selecting fifty competitive cyclists. **Methods:** The anthropometric measurements were of height, body weight, length of the femur, length of the tibia, full leg length, thigh circumference, and calf circumference. Measurements of femur, tibia, and full leg length were measured twice and averaged and thigh and calf circumference were measured thrice under relaxed conditions and under contracted conditions and have been averaged. Cycling performance was assessed through a 1 km individual time trial conducted twice, with the best recorded time used for analysis. The analyses were done through descriptive statistics, Pearson and Spearman correlation, multiple regression analysis, partial correlation analysis, collinearity diagnosis, and residual analysis. **Results:** The outcomes showed that thigh circumference and calf circumference had significant negative relationships with 1 km time trial performance ($r = -0.543$, $p < 0.001$) and performance ($r = -0.414$, $p < 0.01$); the higher the muscle girth, the faster the completion time. Part correlation analysis also revealed that the thigh and calf circumferences had independent effect on the cycling performance in the event of control of either of the two analysis variables but also indicated significant positive relationship between the thigh and calf circumference ($r = 0.550$, $p = 0.001$). On the other hand, cycling performance was not significantly associated with femur length, tibia length, and full leg length. **Conclusion:** Conclusively, muscle girth, especially thigh and calf circumference are a more critical predictor of short distance cycling performance.

Keywords: Anthropometric, Negative Relationships, Circumference, Cycling Performance.

Resumen

Introducción: La relación entre las características antropométricas de las extremidades inferiores y el rendimiento en ciclismo de 1 km entre ciclistas de competición de la Provincia Occidental de Sri Lanka. Se empleó un diseño de investigación transversal de carácter descriptivo. Para la selección de cincuenta ciclistas de competición se utilizó un muestreo aleatorio simple. **Métodos:** Las mediciones antropométricas incluyeron la estatura, el peso corporal, la longitud del fémur, la longitud de la tibia, la longitud total de la pierna, la circunferencia del muslo y la circunferencia de la pantorrilla. Las mediciones de la longitud del fémur, la tibia y la pierna completa se realizaron dos veces y se promediaron; asimismo, las circunferencias del muslo y la pantorrilla se midieron tres veces —tanto en condiciones de relajación como de contracción— y se promediaron. El rendimiento en ciclismo se evaluó mediante una prueba contrarreloj individual de 1 km, la cual se realizó en dos ocasiones, registrándose como resultado el mejor tiempo obtenido. Los análisis se llevaron a cabo mediante estadística descriptiva, correlaciones de Pearson y Spearman, análisis de regresión múltiple, análisis de correlación parcial, diagnóstico de colinealidad y análisis de residuos. **Resultados:** Los resultados mostraron que la circunferencia del muslo y la circunferencia de la pantorrilla mantenían relaciones negativas significativas con el rendimiento en la prueba contrarreloj de 1 km ($r = -0,543$; $p < 0,001$) y con el rendimiento general ($r = -0,414$; $p < 0,01$); es decir, cuanto mayor era el perímetro muscular, menor resultaba el tiempo de finalización. El análisis de correlación parcial también reveló que las circunferencias del muslo y la pantorrilla ejercían un efecto independiente sobre el rendimiento ciclista, incluso al controlar la influencia de cualquiera de estas dos variables de análisis; asimismo, se indicó una relación positiva significativa entre la circunferencia del muslo y la de la pantorrilla (r = 0,550; p = 0,001). Por otro lado, el rendimiento en ciclismo no mostró una asociación significativa con la longitud del fémur, la longitud de la tibia ni la longitud total de la pierna. **Conclusión:** En conclusión, el perímetro muscular —y, en particular, la circunferencia del muslo y la pantorrilla— constituye un predictor más determinante del rendimiento en ciclismo de corta distancia.

Palabras Clave: Antropometría, Relaciones Negativas, Circunferencia, Rendimiento Ciclista.

Introduction

The interaction between the anatomical, physiological, and biomechanical factors contributes to cycling performance via a complex interaction mechanism. The main muscles responsible in generating power are the quadriceps, hamstrings and glutes, whereas the calf muscles gastrocnemius and soleus play an important role in lower leg stability as well as in the provision of force to the pedal. (Gregor, et al., 1991). Within this framework, anthropometric characteristics body size, limb length, muscle girths, are clearly known to be factors of athletic performance. (Zaccagni et al., 2019). To illustrate, elite cyclists have also been found to have higher anaerobic power associated with increased volume of thigh muscle. Likewise, thigh and calf circumference is significantly higher in sprinters (power cyclists) compared to endurance cyclists (e.g. thigh 59.1 cm vs 54.5 cm, calf 37.4 cm vs 36.0 cm). This indicates more muscle hypertrophy in high-power cyclists. (van der Zwaard & de Ruiter, 2019. Therefore, lower limb muscle mass, such as calf and thigh circumference, can be used as crude indices of girth, which tought to theoretically impact on pedaling force, and cycling speed. However, there is surprisingly little direct evidence on how simple anthropometric measurements (calf and thigh circumference, leg length) measure up to actual cycling speed or power outputs. Most research has been done on body composition or complex imaging, whereas simple limb girths have not been compared to performance metrics in a systematic manner (Bassett et al., 1999: Cronin & Hansen, 2005). Among triathletes, greater thigh and calf circumferences were only modestly associated with slower race time (ironman total time) (Ackland et al., 2012: Knechtle et al., 2011), but there is little data on cycles. As a result, we do not have empirical evidence that there can be a means to coach athletes on whether improving calf or thigh girth (via strength training) will correspond to a faster cycling event or whether these could be applied in the context of talent identification.

Material and Methods

Study Design

This investigation employed a quantitative, cross sectional, correlational approach in studying the relationships between lower limb anthropometric variables and cycling performance among a group of competitive cyclists living in the Western Province of Sri Lanka.

Participants

A total of 50 competitive cyclists from the Western Province of Sri Lanka participated in this study. Participants were selected using simple random sampling and were actively engaged in competitive cycling.

Protocol

Anthropometric measurements: Measurements were taken according to the methods standardized by International Society for the Advancement of Kinanthropometry (Esparza-Ros 2019) using standard ISAK procedures (ISAK,2024): Lengths measured twice and averaged, Circumferences measured three times and averaged Cycling performance: 1 km time trial, conducted twice, best time recorded

Data Analyses

Data were analyzed using: Descriptive statistics (Mean, SD), Pearson correlation analysis, Spearman correlation analysis, Multiple regression analysis, Partial correlation analysis, Collinearity diagnostics Statistical significance was set at $p < 0.05$.

Results

The descriptive statistics summarize anthropometric and performance characteristics of 50 participants aged 25-35 years (Mean age = 28.52 ± 3.33 years). The sample demonstrated moderate variability in basic body dimensions, with a mean height of 172.44 ± 6.02 cm and mean body weight of 62.31 ± 8.32 kg, indicating a relatively homogeneous young adult population.

Table 1. Descriptive of Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	50	156.0	183.0	172.44	6.02
Weight (kg)	50	44.0	77.2	62.31	8.32
Age (years)	50	25	35	28.52	3.33
Left Femur (cm)	50	48.0	61.0	54.71	3.26
Right Femur (cm)	50	48.5	61.0	54.84	3.08
Left Tibia (cm)	50	34.7	47.6	42.53	3.54
Right Tibia (cm)	50	35.0	47.0	42.46	3.49
Left Full Leg (cm)	50	93.9	116.0	104.58	4.90
Right Full Leg (cm)	50	93.1	116.0	104.51	4.86
Time (minutes)	50	0.44	1.32	0.94	0.35
Left Relax Thigh (cm)	50	39.5	56.0	46.97	4.25
Left Tight Thigh (cm)	50	39.9	56.0	47.10	4.31
Right Relax Thigh (cm)	50	38.1	58.5	47.68	4.39
Right Tight Thigh (cm)	50	39.2	58.5	47.72	4.23
Left Relax Calf (cm)	50	28.6	39.5	33.47	2.41
Left Tight Calf (cm)	50	28.6	38.5	33.45	2.31
Right Relax Calf (cm)	50	28.2	40.0	33.25	2.56
Right Tight Calf (cm)	50	28.4	40.5	33.12	2.66

The normality of the study variables was determined by passing the test of Kolmogorov-Smirnoff (KS) test and Shapiro-wilk (SW) test consisting of 50 subjects in the sample. The significance value (p) of greater than 0.05 was determined to mean that there was a normal distribution of data and value below 0.05 was a deviation.

(Pearson Correlation Results between Anthropometric Measurements and 1 km Time Trial Performance) Correlation coefficients (r) display the intensity and the direction of the relations, whereas significant values display the statistical significance ($p < 0.05$).

This correlation analysis shows that there is an apparent pattern of body change in terms of body composition as times go on with subcutaneous sections fat measurements exhibiting significant decreases and calf areas measurements characterized by moderate decreases ($r = -0.64$ to -0.59 to -0.45, $p<0.01$). Comparatively, strong or weak positive associations demonstrate a slight increase or maintenance of skeletal structure using bone length (tibia, femur, full leg) (0.06-0.19, non-significant). There is also significant but not significant reduction in weight ($r = -0.29$, $p<0.05$), but not as intensive as the measures. The pattern is similar to a population experiencing fat loss by training, diets or normal body growth and recompositing of the body where adipose tissue is reduced considerably with little change or a slight increase in the musculoskeletal frame.

Table 2. Test of normality

Variable	Kolmogorov-Smirnov Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Height	0.116	50	0.092	0.950	50	0.034
Weight	0.106	50	0.200	0.966	50	0.157
Age	0.183	50	<0.001	0.853	50	<0.001
Left Femur	0.114	50	0.108	0.957	50	0.065
Right Femur	0.120	50	0.069	0.959	50	0.084
Left Tibia	0.155	50	0.004	0.911	50	0.001
Right Tibia	0.133	50	0.027	0.923	50	0.003
Left Full Leg	0.085	50	0.200	0.980	50	0.570
Right Full Leg	0.103	50	0.200	0.980	50	0.556
Time (minutes)	0.279	50	<0.001	0.739	50	<0.001
Left Relax Thigh	0.112	50	0.155	0.964	50	0.131
Left Tight Thigh	0.105	50	0.200	0.958	50	0.075
Right Relax Thigh	0.091	50	0.200	0.978	50	0.480
Right Tight Thigh	0.072	50	0.200	0.982	50	0.656
Left Relax Calf	0.100	50	0.200	0.981	50	0.581
Left Tight Calf	0.105	50	0.200	0.978	50	0.473
Right Relax Calf	0.115	50	0.095	0.977	50	0.435
Right Tight Calf	0.135	50	0.024	0.964	50	0.128

Table 3. Summary of Pearson Correlation Results

Variable	Correlation (r)	Significance (p)
Left Relax Thigh	-0.633	<0.001
Left Tight Thigh	-0.640	<0.001
Right Relax Thigh	-0.605	<0.001
Right Tight Thigh	-0.594	<0.001
Left Relax Calf	-0.412	0.003
Left Tight Calf	-0.448	0.001
Right Relax Calf	-0.418	0.003
Right Tight Calf	-0.368	0.009
Left Femur	0.064	0.660
Right Femur	0.068	0.639
Left Tibia	0.193	0.180
Right Tibia	0.171	0.235
Left Full Leg	0.160	0.267
Right Full Leg	0.153	0.290
Height	0.080	0.581
Weight	-0.289	0.042

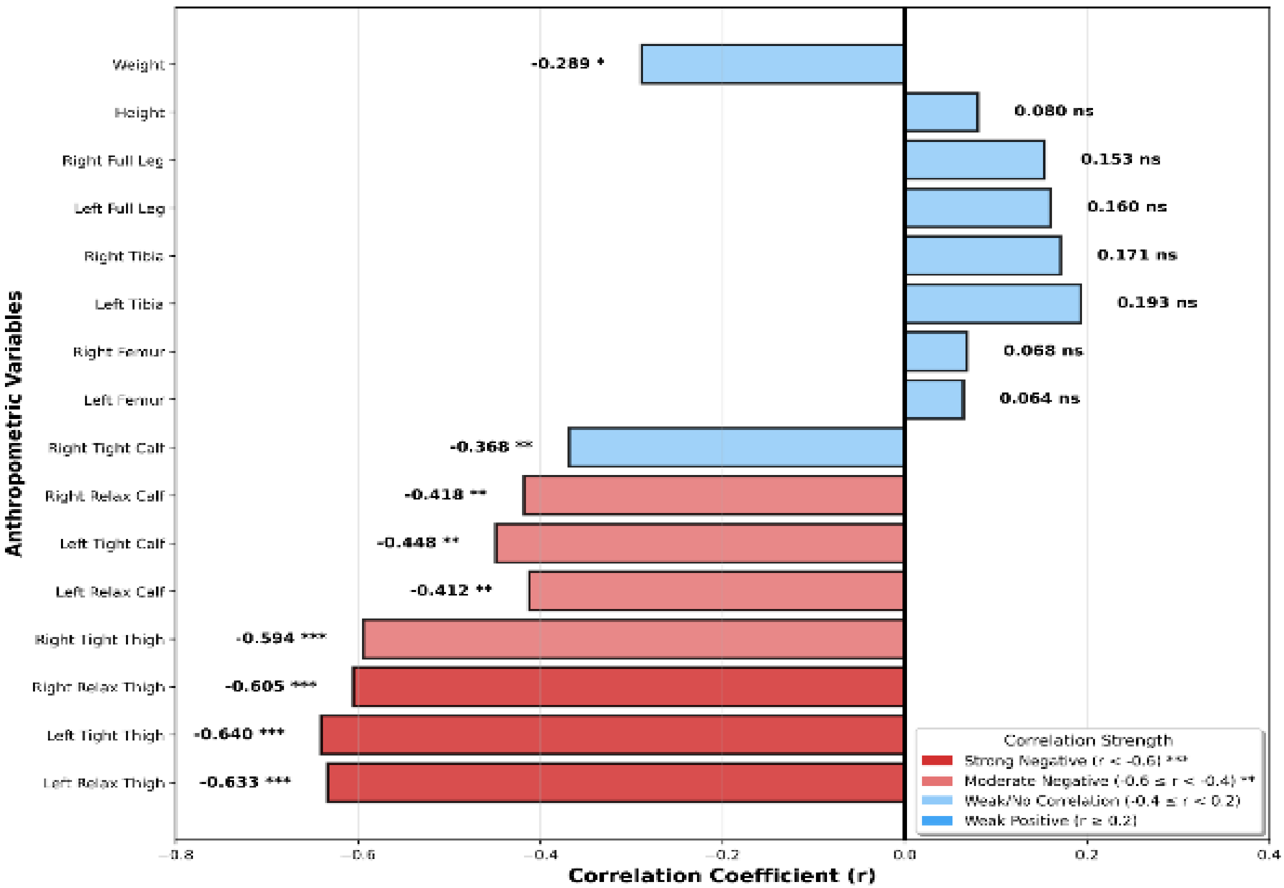

Figure 1. Correlation Coefficients Between Time and Anthropometric Variables

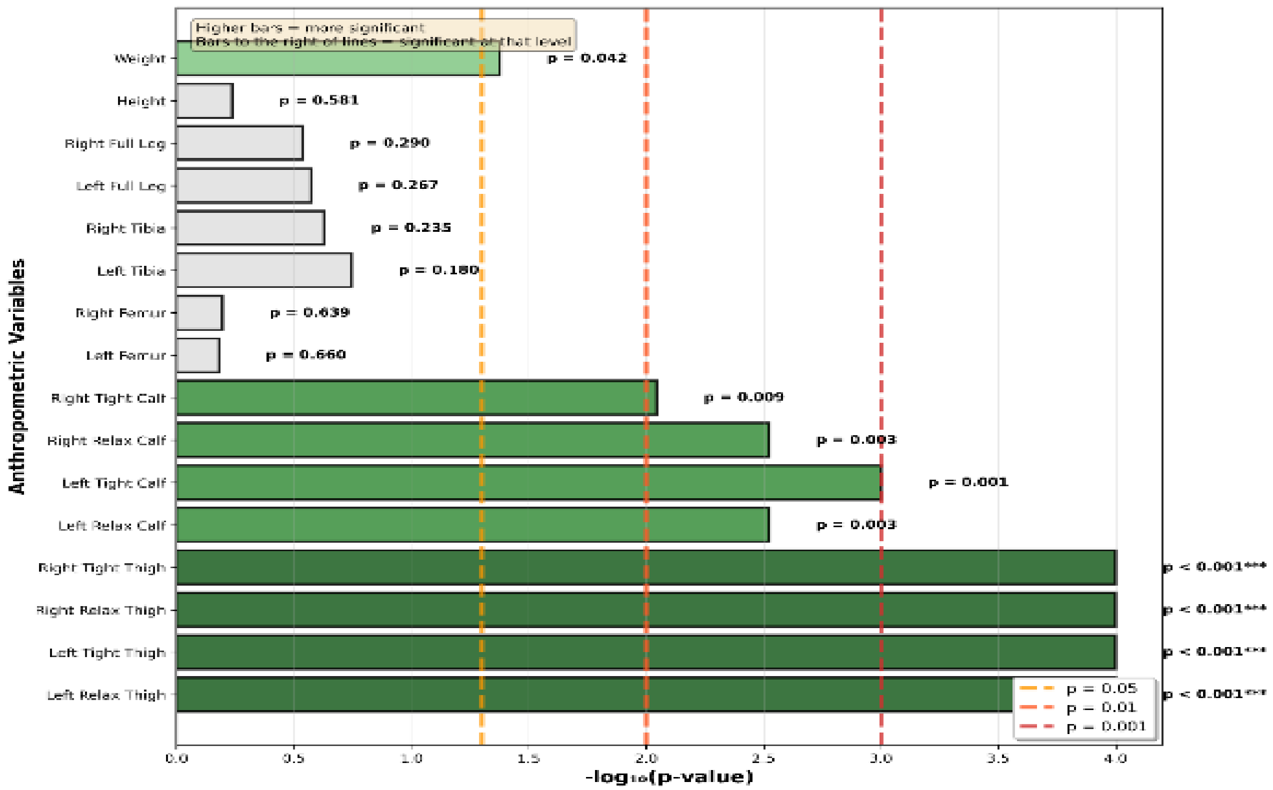

Figure 2. Statistical significance (p-values) of correlations with time

The p-value representation shows that there are significant statistical changes in time in anthropometric measurements, and the degree of change reliability of the body composition variables in the hierarchy is evident. The highest statistical significance is observed in the measurement of the thigh ($p < 0.001$), whose bars far surpass the red line which represents the significance value of 0.001, meaning that the changes that have occurred over the period of time with regard to the thigh are robust and reliable to the highest degree unlike to appear randomly. Measurements of calf reveal moderate and strong (p = 0.001 to 0.009) significance, above the orange (p = 0.05) and red (p = 0.01) lines, that there are significant changes in the measurement over time. Weight does not come much beyond significance (p = 0.042), merely passing the orange line, indicating a small, but statistically significant reduction. On the contrary, skeletal computations (height, leg lengths, tibia, femur) are not statistically significant ($p > 0.05$), and their short gray bars show that the variation in the values can be accounted by random error variations and not any systematic temporal variations. This trend can verify that the loss of subcutaneous fat, especially in the thighs, is the most precise as well as statistically certain alteration of this population with the passage of time, the subsequent structural skeletal dimensions are also largely constant.

The relationship of calf size to time performance is moderate negative (r -0.388, p-0.01).

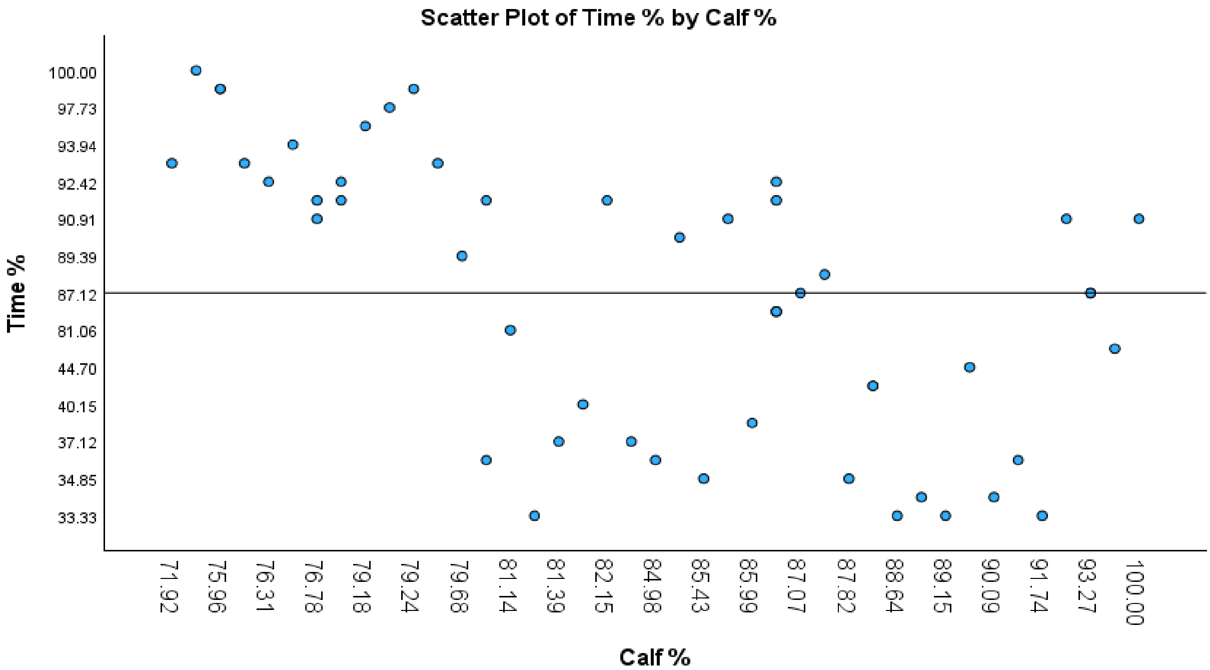

Figure 3. Time percent vs. Calf Circumference percent.

This scatter plot shows the correlation between Calf percent with Time percent, which indicates a moderate negative correlation where high percentages of calf also have high percentages of time where a high percentage of calf has a high percentage of time as in the previous analysis a significant correlation was observed (r) in bivariate correlation between Calf percentages and Time percentages (-0.388, p = 0.01). The data points depict a significant amount of scatter around the negative trend, which means that as much as calf circumference explains some variability in time performance (some 15 to 20 percent by r 2), there is still much individual variability. Interestingly, high values of Time 3 4 of at least 90-100 mean present concentrations with lower Calf 3 4 values (71 -79 90 -100) and similarly, low values of Time 3 4 (33 -45 33 -100) also occur at higher values of Calf 3 4 than 86 -100 are, indicating that those with larger calf circumferences are expected to exhibit lower performance times. The data is split into two with the horizontal line referred to at: approximately 87% Time, with majority of smaller-cuff individuals being above this reference line and the larger-cuff individuals being above and below the reference line. Nonetheless, the vertical spread at any particular Calf direction was found to be substantial, which explains, why calf circumference was not found significant in the multiple regression model (p=0.397) when the interrelationships among the anthropometric variables were controlled- the predictive power has been diminished under the presence of thigh circumference which occurred to be the strongest predictor in the multiple regression model.

The negative relationship (r -0.610, p -0.001) in the plot between thigh size and time performance indicates that thigh circumference is the main anthropometric predictor.

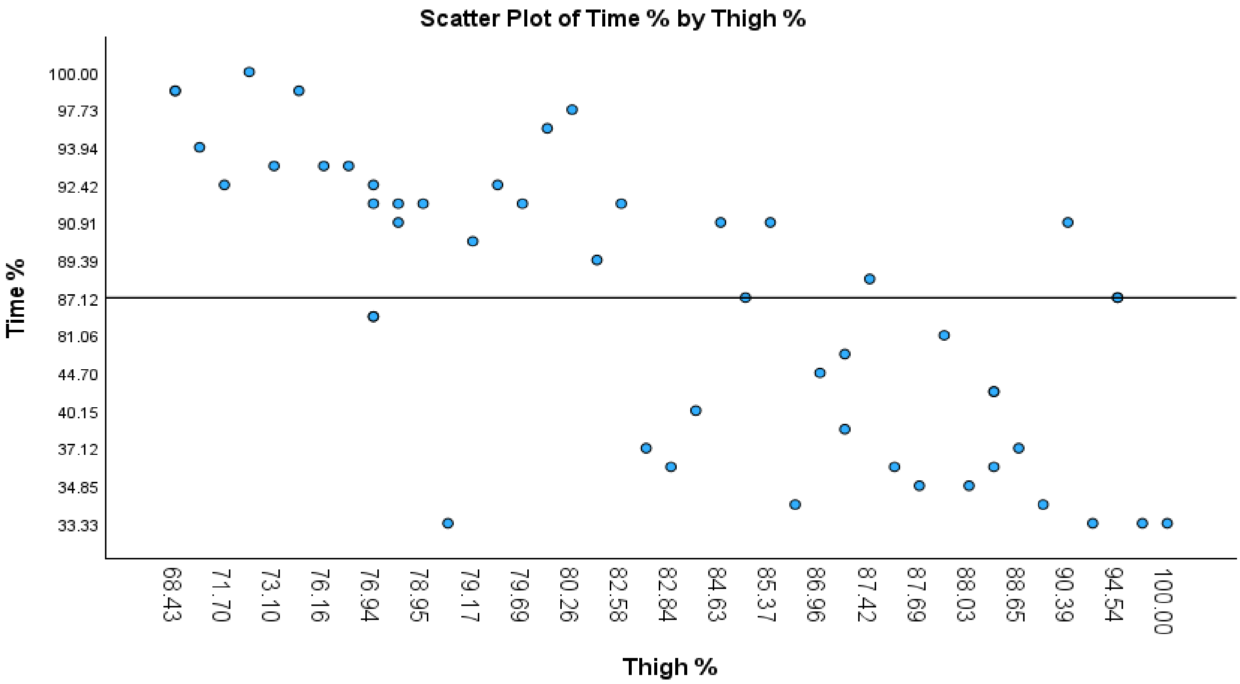

Figure 4. Scatter Plot of Time Percentile by Thigh Circumference Percentile**.**

This scatter plot illustrates the dependence between Thigh percentage and Time percentage, and indicates that there is a strong negative correlation where higher thigh percentage is obviously correlated with lower percentage of time, which is in line with the high dependency of bivariate correlation (r = -0.610, p -0.001) and the significance of thigh as the dominant predictor in the regression model (= -0.731, p -0.001). The visual trend indicates that there is a strong left-right downward trend in the gradient of Time percentage (93 to 100%) with high percentages of Time (33 to 44) concentrated on low percentages of Thigh (86 to 100). This demanding directional tendency shows that participants whose thigh circumferences are larger always record a lower performance time, which accounts for about 37 per cent of the time variance (r 2 = 0.372). The closer concentrations around the trend line, in comparison to the calf scatter plot, points to the predictive ability of the thigh, the fewer vertical scratches at any given thighs' percentage translates to greater predictability. The horizontal reference at around 87 percent Thigh Time is an effective dividing line between fast and slow performers (below and above the line, respectively, most had Thigh percentages less than 80 when performing). This illustration makes it evident that the reasons why the circumference of the thigh became the only crucial predictor of the multivariate analysis was that this measure reflects the fundamental propulsive muscle mass in its entirety.

Based on the analyses, the girth of the lower limbs, especially the thigh and calf circumference, have a strong effect on the performance of 1 km cycling, but the bone lengths (femur, tibia, full leg) have no significant effect. Thicker thigh and calf circumference characteristics predict more (faster) cycling. These results indicate that muscle mass or girth of lower limbs is more significant than limb length is in the short distance cycling of competitive cyclists in the Western Province of Sri Lanka.

Discussion

Performance and Thigh Circumference

Circumference of thighs was seen to be the most powerful predictor of the performance during cycling with correlation coefficients of r =-0.594 to r =-0.640 (p=0.001). The multiple regression test also supported the fact that the only statistically significant predictor amongst the three anthropometric variables was the circumference of the thigh (r= -0.731, p<0.001). This result implied that an increased mass of thigh muscle is a determining factor of short distance cycling. The significance of this negative correlation is that cyclists with large circumference of the thighs finished the 1 km time trail at a shorter time which showed their performance is better. This is explained by the fact that thigh muscles, especially, the quadriceps and hamstrings, contribute to the creation of the power during the pedal stroke. Higher muscle cross-sectional size generally means higher production power potential that is necessary in the generation of explosive powers needed in cycling sprints. The analysis of the partial correlation, which had factored in calf circumference, kept the strong relationship between the thigh circumference and the performance at a strong level (r = -0.543, p< 0.001) which meant that the impact of the thigh muscle mass on the cycling performance was independent of its relationship with the overall lower limb muscularity.

Calf Circumference and Performance

Time-trial performance also had strong negative correlations with calf circumference (r = -0.368 to -0.448, p = 0.01), which were not as strong as the relationships in the case of thigh circumference. Calf circumference was not statistically significant in the multiple regression model (0.154, p 0.397) and this indicates that calf circumference when used together with thigh circumference does not have significant contribution to the performance. Nevertheless, the partial correlation test showed that calf circumference retained a substantial value of performance (r = -0.414, p = less than 0.01) in case the thigh circumference is regulated. This implied that although it can be indicated that the mass of calf muscle is a secondary factor relative to thigh muscles, nevertheless, they contribute to cycling performances. The gastrocnemius and the soleus muscles of a calf also help in the plantar flexion of the ankle during the downstroke of the pedal cycle, and act to stabilize during the peddling cycle. The positive relationship between thigh and calf circumference showed a moderate upward correlation (r=0.550, p=< 0.001) showing that cyclists who get the development of bigger thigh muscles will have also bigger calf muscles, which is the general lower-limb muscular growth. This correlation could be the reason of such interdependence where the calf circumference seems to have a significant influence in a simple correlation and the lack of significance in multiple regression model where multicollinearities exist.

Conclusion

This study demonstrates that lower-limb muscularity, particularly thigh circumference, is a meaningful anthropometric determinant of short-distance cycling performance among competitive cyclists in the Western Province of Sri Lanka. The findings showed significant negative relationships between both thigh and calf circumferences and 1 km time-trial completion time, indicating that cyclists with greater muscular girth tended to complete the trial faster. Among the variables examined, thigh circumference emerged as the strongest independent predictor of performance, while calf circumference showed a supportive but less dominant contribution. In contrast, skeletal measures such as femur length, tibia length, and full leg length did not show significant associations with performance, suggesting that muscular development is more influential than limb length in short-duration, high-intensity cycling events. These results highlight the practical value of simple anthropometric measurements for performance monitoring, talent identification, and training design in competitive cycling. Coaches and athletes may therefore benefit from emphasizing strength and conditioning strategies that enhance lower-limb muscular development, especially in the thigh region. However, causal interpretations should be made cautiously. Future studies with larger and more diverse samples, as well as direct measures of muscle mass and power output, are recommended to further clarify the mechanisms linking anthropometry and cycling performance.

References

Ackland, T.R., Timothy, G.L., Jorunn, S.B., Ronald, J.M., Nanna, L.M., Arthur, D.S.T., Wolfram Muller. (2012). Current status of body composition assessment in sport: review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the IOC Medical Commission, *Sports medicine* 42(3), 227-249. https://doi.org/10.2165/11597140-000000000-00000

Buvanendiran, P., Virupaksha, N.D. (2018) An investigation of anthropometric measurements among elite athletes. *Indian Journal of Physical Education, Sports and Applied Science*, 8(2), 22-28.

Cronin, J., Hansen, K. (2005). Strength and power predictors of sports performance. *Journal of Strength and Conditioning Research*, 19(2), 379-385.

Esparza-Ros, F., Vaquero-Cristóbal, R. and Marfell-Jones, M., (2019). *International standards for anthropometric assessment*. International Society for the Advancement of Kinanthropometry (ISAK).

Gregor, R.J., Broker, J.P., Margaret, R.M. (1991). The Biomechanics of Cycling. *Exercise and Sport Sciences Reviews*, 19(1), 127-170.

ISAK (2024): International Standards for Anthropometric Assessment. International Society for The Advancement of Kinanthropometry, 2024 edited by F. Esparza-Ros R. Vaquero-chrisobal and M. Marfell-Jones.

Knechtle, B., Knechtle, P., Rosemann, T., Lepers, R. (2011). Personal best marathon time and longest training run, not anthropometry, predict performance in recreational 24-hour ultrarunners. *Journal of Strength and Conditioning Research,* 25(8), 2212-2218. https://doi.org/10.1519/JSC.0b013e3181f6b0c7

Kyle, C.R., Passfield, L.O.U.I.S., Broker, J.P., Burke, E.R., Comparing cycling world hour records, 1967-1996: modeling with empirical data. *Medicine & Science in Sports & Exercise,* 31(11),1665–1676.

van der Zwaard, S., de Ruiter, C.J., Jaspers, R.T., de Koning, J.J. (2019). Anthropometric clusters of competitive cyclists and their sprint and endurance performance. *Frontiers in Physiology*, 10, 1276. https://doi.org/10.3389/fphys.2019.01276

Zaccagni, L., Lunghi, B., Barbieri, D., Rinaldo, N., Missoni, S., Saric, T., Sarac, J., Babic, V., Rakovac, M., Bernardi, F., Gualdi-Russo, E. (2019). Performance prediction models based on anthropometric, genetic and psychological traits of Croatian sprinters. *Biology of Sport*, 36(1), 17-23. https://doi.org/10.5114/biolsport.2018.78901

Acknowledgement

I would like to express my deep gratitude to Dr. P. Buvanendiran for assisting me during collection of data.

Funding

There is no external funding to declare

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Informed Consent Statement

All the athletes included in the study provided written informed consent.

About the License